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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/039,635	01/02/2002	Charles T. Black	YOR9-2001-0319-US1	9290

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EXAMINER
JOHNSTON, PHILLIP A

ART UNIT	PAPER NUMBER
2881	

DATE MAILED: 06/18/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/039,635	BLACK ET AL.	
	Examiner	Art Unit	
	Phillip A Johnston	2881	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____ .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-29 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-29 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 02 January 2002 is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 2 .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

Detailed Action

Claims Rejection – 35 U.S.C. 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

2. Claims 1-9 are rejected under 35 U.S.C. 102(e) as being anticipated by U.S. Patent Pub. No. 2002/0084410 to Colbert et al.

Colbert (410) discloses a probe with tip comprising one or more molecular nanotubes. When attached to an appropriate motion transducer (piezoelectric, magnetic, etc.) the probe is capable of sensing, measuring, analyzing, and modifying objects with nanometer resolution and sensing, measuring, analyzing, moving, manipulating, and modifying objects with nanometer dimensions.

A method for making such devices is disclosed, which includes the steps of (1) providing a nanotube-containing material; (2) preparing a nanotube assembly comprising at least one nanotube from the nanotube-containing material; and, (3) attaching the nanotube assembly to a macroscopically manipulably mounting element.

The devices of the present invention have a number of advantages over conventional microscopy probes (e.g. STM and AFM). A probe tip consisting of a single molecular nanotube or a few such tubes has the advantage that all its constituent atoms are covalently bonded in place.

Broadly, the macroscopically manipulable nanoscale devices of the present invention comprise a nanotube assembly attached to a mounting element that permits macroscopic manipulation or observation. In a preferred form this device comprises a nanotube probe tip assembly made up of one or more single-wall and/or multi-wall nanotubes. This assembly is connected to a mounting element at one end, with the other end being free and capable of coming into direct contact or near proximity to the object being sensed, measured, analyzed, moved, manipulated, and/or modified. The free "sensing end" has a transverse dimension in the nanometer range. The "sensing end" interacts with objects being sensed, measured, analyzed, moved, manipulated, and/or modified by means, which are (either individually or in combination) physical, electrical, chemical, electromagnetic, or biological. These interactions produce forces, electrical currents, or chemical compounds which reveal information about the object and/or modify that object in some way.

For many analytical applications, the currently employed mounting systems can be employed in carrying out the present invention. In this regard, the cantilever or probe tip of various known proximity probes such as STM, AFM and MFM devices can serve as the mounting element of the present invention. See Paragraphs [0009]-[0012], [0034] and [0037].

Colbert (410) also discloses that the nanotube assembly of the present invention can be formed from any geometrically regular molecular nanotubes, and is preferably prepared from isolated, purified carbon nanotubes produced by any of the methods described herein. The carbon nanotube can be multi-wall or single-wall, with single-wall carbon nanotubes being preferred. The single-wall carbon nanotube can be of the metallic type, i.e. armchair or (n,n) in configuration or of the insulating type, i.e. (m,n) in configuration. For applications requiring electrical conductivity, the most preferred are (10,10) SWNTs (Single Walled Nanotubes). The carbon nanotubes may also be endohedrally modified by including one or more internal species inside the tube structure. Suitable endohedral species include metals (e.g. Ni, Co, Yb), ions, small molecules and fullerenes. Endohedral species may have magnetic properties (i.e. ferromagnetic, paramagnetic), electrochemical properties, optical properties, or other suitable properties.

The structure of the nanotube assembly can vary depending on the purpose for which the device is used. In many cases, a single nanotube will serve as the nanotube assembly. Referring to FIG. 1a, such an assembly is shown. Nanotube assembly 100 consists of a mounting element 104 with a single nanotube 102 attached thereto. Small bundles of generally parallel and coterminating nanotubes containing from about 2-100 nanotubes, preferably about 2 to about 20 nanotubes and most preferably about 5 to about 10 nanotubes, can also be employed. (See FIG. 1b). This assembly 120 consists of a bundle of nanotubes 122. This bundle 122 can be held together by van der Waals forces or otherwise bound together.

In one preferred embodiment shown in FIG. 1c, a bundle of nanotubes 142 forming the nanotube assembly 140 includes at least one nanotube 144 that extends beyond the end of the other nanotubes in the bundle. This extension can result from employing at least one longer nanotube or bonding an extension length to the end of the bundle (i.e. to one of the bundle length nanotubes). Also, as shown in FIG. 1d and described below, the nanotube assembly 160 may be coated (preferably after attachment to the mounting element) with a suitable material 164, wherein at least a portion of the nanotube assembly is coated with a material selected from the group consisting of thermosetting polymers, thermoplastic polymers, UV curing polymers, silicon and metals.

The diameter of the nanotube assembly can be uniform along its length (as in the embodiment of FIGS. 1(a) and 1(b) or non uniform along its length (as in the embodiments of FIGS. 1(c) and (d)). Even in the latter forms it is preferred that the tip section of FIGS. 1(c) and (d) respectively is of uniform diameter. Useful diameters can range from a few nm (for single tubes) up to about 100 nm for ropes or bundles. Preferred are bundles having diameters of about 2 nm to about 50 nm, and most preferred are diameters of about 5 nm to about 20 nm. See paragraphs [0040]-[0043] and Page 17, Claim 60.

Colbert (410) further discloses if electrical connection to the nanotube sample is required such connection can be guaranteed (despite the use of insulating adhesives) by applying the adhesive to only the very tip of the mounting device and selecting only the longest outliers to ensure that there is direct contact between the uncoated,

electrically conducting portion of the mounting device tip (beyond the adhesive covered portion) and the nanotube sample.

In some applications, the mounted nanotube sample may be subjected to mechanical or environmental stresses which make it desirable to make the attachment to the mounting device more robust. This is accomplished by the application of a coating over the nanotube sample and mounting device tip, while this has been achieved by dipping the assembly in a fluid solution of the coating material.

Coatings applied in this way can include cyanoacrylate, methacrylate (modified and pure, both in two part cure formulation and a UV cure formulation), Paryiene2 and polyimide. Other types of coatings that may be applied from the vapor phase include silicon from the UV decomposition of silanes in an inert atmosphere as well as silicon dioxide from the decomposition of silanes in an oxygen atmosphere. See Paragraphs [0056]-[0058].

Colbert (410) still further discloses the production of a substantially two-dimensional array made up of single-walled nanotubes aggregating (e.g., by van der Waals forces) in substantially parallel orientation to form a monolayer extending in directions substantially perpendicular to the orientation of the individual nanotubes. Such monolayer arrays can be formed by conventional techniques employing "self-assembled monolayers" (SAM) or Langmiur-Blodgett films. Typically, SAMs are created on a substrate, which can be a metal (such as gold, mercury or ITO (indium-tin-oxide)). The molecules of interest, here the SWNT molecules, are linked (usually covalently) to the substrate through a linker moiety. Langmiur-Blodgett films are

formed at the interface between two phases, e.g., a hydrocarbon (e.g., benzene or toluene) and water. Orientation in the film is achieved by employing molecules or linkers that have hydrophilic (head group) and lipophilic (tail group) moieties at opposite ends. See Paragraphs [0148] and [0149].

Claims Rejection – 35 U.S.C. 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 1-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Colbert (410), as applied above to Claims 1-9.

Regarding Claims 10-29, Colbert (410) discloses that the article of manufacture comprises a macroscopic mounting element capable of being manipulated or observed in a macroscale environment, and a nanoscale nanotube assembly attached to the mounting element. The article permits macroscale information to be provided to or obtained from a nanoscale environment. A method for making a macroscopically manipulable nanoscale devices comprises the steps of (1) providing a nanotube-containing material; (2) preparing a nanotube assembly device having at least one

carbon nanotube for attachment; and (3) attaching said nanotube assembly to a surface of a mounting element. See Abstract.

Colbert also discloses in Claims 65 and 69, A method for making a macroscopically manipulable nanoscale device comprising: providing a nanotube-containing material; preparing a nanotube assembly having at least one nanotube; and attaching said nanotube assembly to a surface of a mounting element. Wherein said step of attaching said nanotube assembly to a surface of a mounting element comprises: translating said mounting element toward said nanotube assembly; contacting said mounting element and said nanotube assembly; and translating said mounting element away from said nanotube assembly.

It is implied herein that the method of attaching a nanotube to the probe tip in accordance with Colbert (410) above is equivalent to "dipping" as recited in Claim 10.

Colbert (410) as applied above does not specifically disclose "dipping a probe tip into a solution of nanoparticles", as recited in Claim 10; however, Colbert (410) further discloses that the product of a typical process for making mixtures containing single-wall carbon nanotubes is a tangled felt which can include deposits of amorphous carbon, graphite, metal compounds (e.g., oxides), spherical fullerenes, catalyst particles (often coated with carbon or fullerenes) and possibly multi-wall carbon nanotubes. The single-wall carbon nanotubes may be aggregated in "ropes" or bundles of essentially parallel nanotubes.

When material having a high proportion of single-wall nanotubes is purified as described herein, the preparation produced will be enriched in single-wall nanotubes,

so that the single-wall nanotubes are substantially free of other material. One preferred purification process comprises heating the SWNT-containing felt under oxidizing conditions to remove the amorphous carbon deposits and other contaminating materials. After oxidation, and optionally saponification and neutralization, the purified nanotubes may be collected by settling or filtration preferably in the form of a thin mat of purified fibers made of ropes or bundles of SWNTs, referred to hereinafter as "bucky paper". In a typical example, filtration of the purified and neutralized nanotubes on a TEFLON membrane with 5 micron pore size produced a black mat of purified nanotubes about 100 microns thick. The nanotubes in the bucky paper may be of varying lengths and may consists of individual nanotubes, or bundles or ropes of up to 10^3 single-wall nanotubes, or mixtures of individual single-wall nanotubes and ropes of various thicknesses.

Alternatively, a molecular array of SWNTs can be made by "combing" the purified bucky paper starting material. "Combing" involves the use of a sharp microscopic tip such as the silicon pyramid on the cantilever of a scanning force microscope ("SFM") to align the nanotubes. Specifically, combing is the process whereby the tip of an SFM is systematically dipped into, dragged through, and raised up from a section of bucky paper. An entire segment of bucky paper could be combed, for example, by: (i) systematically dipping, dragging, raising and moving forward an SFM tip along a section of the bucky paper. See Paragraphs [0102]-[0104], [0107], and [0154].

It is implied herein that the nanotubes collected by settling or filtration preferably in the form of a thin mat of purified fibers is equivalent to "a solution", as recited in Claim 10.

Therefore it would have been obvious to one of ordinary skill in the art that the method of attaching nanotubes in accordance with Colbert (410), can be modified to include "dipping the scanning probe microscope tip into a solution of nanoparticles; and withdrawing said scanning probe microscope tip from said solution; wherein said step of dipping causes said nanoparticles to attach to said scanning probe microscope tip", as recited in Claims 10, and 25-28.

Colbert (410) still further discloses that the SWNT molecular array tip should be heated to a temperature sufficient to cause growth and efficient annealing of defects in the growing fiber, thus forming a growth and annealing zone at the tip, as recited in Claim 22. see Paragraph [0168]

Conclusion

5. Any inquiry concerning this communication or earlier communications should be directed to Phillip Johnston whose telephone number is (703) 305-7022. The examiner can normally be reached on Monday-Friday from 7:30 am to 4:00 pm. If attempts to reach the examiner by telephone are unsuccessful, the examiners supervisor John Lee can be reached at (703) 308-4116. The fax phone numbers are (703) 872-9318 for regular

response activity, and (703) 872-9319 for after-final responses. In addition the customer service fax number is (703) 872- 9317..

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703 308 0956.

PJ
June 13, 2003

JOHN R. LEE
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